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SURVIVAL IN NUCLEAR WAR
A VANISHING PROBABILITY

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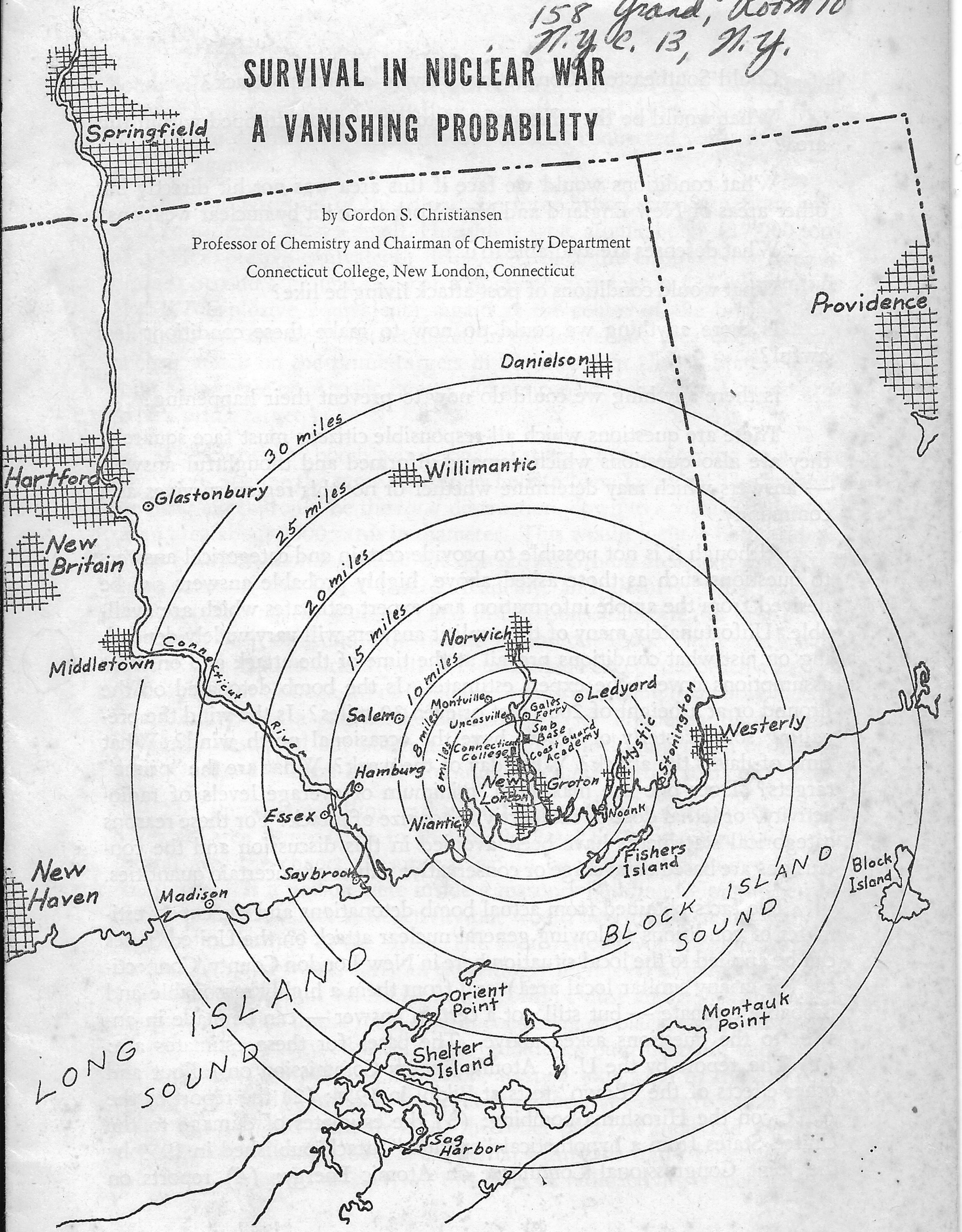

Could Southeastern Connecticut survive a nuclear attack?

What would be the effects of an atomic weapon dropped within this area?

What conditions would we face if this area was not hit directly but other areas of New England and New York were hit by nuclear weapons?

What defenses are available to us?

What would conditions of post-attack living be like?

Is there anything we could do now to make these conditions less awful?

Is there anything we could do now to prevent their happening?

These are questions which all responsible citizens must face squarely; they are also questions which demand informed and thoughtful answers — answers which may determine whether or not this region survives as a community.

Although it is not possible to provide certain and categorical answers to questions such as those asked above, highly probable answers *can* be derived from the ample information and expert estimates which are available. Unfortunately many of the explicit answers will vary widely depending on just what conditions prevail at the time of the attack and on what assumptions govern the expert estimates. Is the bomb detonated on the ground or at a height of 2000 feet or even 30 miles? Is the wind the prevailing southwesterly or do we have the occasional north wind? What time of day is the attack? What day of the week? What are the "prime" targets? Does one use maximum, minimum or average levels of radioactivity? or lethal dose of radioactivity? or size of attack? For these reasons categorical statements have been avoided in this discussion and the conclusions are based on average or conservative values of uncertain quantities.

The facts obtained from actual bomb detonations and the expert estimates of conditions following general nuclear attack on the United States can be applied to the local situation here in New London County, Connecticut (or in any similar local area) and from them a highly reasonable and probable estimate — but still not a certain answer — can be made in answer to the questions asked above. The bases for these estimates are: (1) The report by the U. S. Atomic Energy Commission on fallout and other effects of the "Bravo" tests at Bikini in 1954; (2) the report by the A.E.C. on the Hiroshima bombing; (3) the estimates of damage to the United States from a hypothetical "medium" attack published in 1959 by the Joint Congressional Committee on Atomic Energy; (4) reports on

bomb effects published by other government agencies such as the 1960 White House Conference on Fallout Protection; and (5) analyses of these reports and estimates by scientists not directly connected with the A.E.C. or other agencies.

For the purposes of this discussion three hypothetical situations have been considered. First a small, Hiroshima type, atomic bomb (17,000 tons of TNT explosive equivalent) detonated above the Groton-New London bridge. Second a ground burst of a nominal 20 megaton (24 million tons of TNT explosive equivalent), again at the center of the bridge. And third, no nuclear weapons detonated in the immediate area but a general nuclear attack on the prime targets in Northeastern United States. (The Joint Committee on Atomic Energy did not consider the New London area to be a prime target.)

The Hiroshima bomb was detonated at 8:15 in the morning on a clear day; let us assume the same conditions here in New London. The immediate blast effect would be the *total* destruction, down to a virtual flattening, of an area about 2000 yards in diameter. This would include both bridges, all of East New London, all of the downtown Groton area, part of Electric Boat, most of the Coast Guard Academy, and all of the highway approaches with nearby buildings and installations. The area of destruction of heavily built brick buildings would extend out about a mile and a half. This would include virtually all of New London except the beach areas, all of Connecticut College, all of Groton Borough including the whole Electric Boat facility, and a part of the Submarine Base. Frame buildings would be totally destroyed out about a mile further, including much of Waterford, Quaker Hill, the Naval housing areas, and further parts of Groton.

The immediate killing radiation from the bomb detonation would cover an area comparable to that of the total blast destruction. In this central area the chance of survival would be virtually nil under any circumstances. If a person were inside a masonry building he might be protected from the direct radioactivity but would be crushed along with the building or burned in the fires. The local fallout would begin within a few minutes and would carry an exceedingly high level of damaging radioactivity. This fallout would be in the form of dust and flakes and larger particles and also in the form of rain consisting of black, sooty, dust-laden drops. The intensity of the fallout radiation would decrease with radial distance from the point of explosion, warped somewhat by the low level winds. It is hard to estimate the level of radioactive exposure which would result but it would certainly be of the order of a few thousand roentgens per hour at a distance of a few (perhaps three or four) miles out from the center. In terms of survival, this level of radioactivity is such that five

or ten minutes of exposure would surely be lethal. But the level of radioactivity would fall off rapidly both with time and with distance out from the center. Within the four mile circle it would decrease to around a few hundred roentgens per hour by nightfall so that a person at Connecticut College or the Sub Base, for example, would need to be exposed in the open for an hour or so to get a fatal dose of radiation. The levels of radioactivity beyond the immediate area, out to Mystic, Norwich or Niantic, would never become so great as close in near the point of detonation and also would fall off rapidly with time. In these communities a person could avoid serious injury from radiation by taking shelter immediately and remaining inside for a few days.

Although the levels of direct radiation from fallout would drop to small fractions of their original killing power within a few days, there would be serious dangers for some weeks. It would be necessary to decontaminate most of the built up areas and to completely avoid using some facilities which are normally part of our lives. It would be particularly necessary to protect children from radiation. The double reasons of genetic damage to those who will be the parents of the next generation and the very much greater susceptibility of growing children to radiation damage would limit the lives of children in these communities to total protection (that is, constant living in an adequate shelter) for a few weeks and to very carefully restricted time outside of uncontaminated and adequately shielded buildings for a few months. The parents of these children would probably be willing to risk some levels of radiation damage (provided they were also willing never to have more children) in order to do the necessary jobs of supporting life in a shelter.

The most serious source of radiation damage would be the ingestion of particles of radioactive fallout. This could be done through breathing contaminated air (even the most elegant shelters usually do not have adequate supplies of clean air), through contaminated food or water, or through open wounds such as cuts or burns. Buildings or open areas could ultimately be decontaminated but once radioactive material gets inside the human system it remains there as a subtle and virulent source of radioactive poison throughout the lifetime of the radioactivity — or the poisoned individual. It is also a fact that many substances which are innocuous outside the body, because a few inches of air or a layer of clothing will absorb their type of radiation, are viciously destructive if ingested where they come in direct contact with body tissues.

Fire would be the most destructive effect of the bomb, both to physical structures and human life. The great fire ball which surrounds the bursting bomb within a few millionths of a second reaches a temperature

of several million degrees. This tremendous source of heat radiates down over a huge area around the center of the detonation so that temperatures on the ground out three miles or more reach a thousand degrees. This heat causes third degree burns (charring of the flesh) to people in the open and sets fire to most combustible things such as trees, grass, frame buildings, etc. These fires, plus the many others caused by broken electric wires, gasoline storage tanks and gas mains, and by other blast effects, tend quickly to congeal into a single huge fire encircling the center of the bomb blast. At Hiroshima and in a few other massive fire bombing raids in World War II this phenomenon, called a "fire storm," happened. It is quite probable that a fire storm extending out from four to five miles would be the outcome of this hypothetical "small" atomic bombing of New London. The ring of fire would include all of Waterford, probably spare Niantic, but would include Uncasville, Gales Ferry, much of Ledyard, probably include West Mystic and Noank, certainly all of the Submarine Base, and the rest of the town of Groton. The small local fires would join into bigger ones; the bigger ones would congeal into a solid mass of fire rushing toward the center of the destroyed area. The heavy, raging fires near the center would create an up-draft like a huge chimney and winds above 100 miles an hour would sweep the whole conflagration toward the center. It would rage completely out of control, consuming everything combustible before it — including most of the oxygen. Many people in this area who otherwise might have survived would be killed by suffocation. In this area a fallout shelter would serve only as a fiery trap in which lives saved from radiation would be consumed by fire. This is not a hypothetical possibility. It is what happened in several cities under full wartime conditions of alert and disaster preparation. And it happened in areas much better prepared than we are or are likely to be and in terrain and conditions of woodland cover much less likely to develop into a fire storm than we have in this area. In those war-time incidents, fire departments and public safety facilities were totally incapable of coping with the fire storm; in fact, they along with other people and agencies were consumed in the fire.

The few survivors in the communities of Groton and New London would almost certainly have to be evacuated. All necessary facilities for a functioning community would be either totally or largely destroyed. The State Police barracks and all its occupants would have been totally crushed in the initial blast. The New London and Groton police stations, the railroad station and yards, the New London City Hall, all the stores in both downtown areas, most of the fire stations and apparatus, and all the schools would have been blasted into totally unrecognizable rubble. All ordinary civil functions would have been completely destroyed; trans-

portation and communication with outside areas would be virtually non-existent; most of the people would be dead and the survivors would almost all be seriously injured from burns, shock, radiation, and wounds from flying objects. A sizeable area, including the normal access to the communities, would be totally unusable for a period of months. Lawrence Memorial Hospital would have been (a) at least half destroyed by the initial blast, (b) seriously contaminated with radioactivity, and (c) probably consumed by fire. Norwich State Hospital would have been only partially damaged and only mildly contaminated, certainly in part usable as an improvised treatment center for bomb casualties. Backus Hospital would be largely intact except for fallout contamination. Its early use would require heroic efforts of decontamination by people willing to suffer radiation sickness and to risk increased likelihood of cancer, shortening of life expectancy, and possible death from radiation within a few weeks. If decontamination could be accomplished and if enough of the doctors and nurses happened to be away from the area of heavy initial destruction, it would then be possible to treat at least partially the huge numbers of casualties from areas outlying the immediate bomb area.

Is it possible to make sensible estimates of the numbers of dead and wounded and of the reasonably unhurt survivors? It hasn't even been possible to determine these facts accurately for Hiroshima to this day. Out of the 300,000 population, between a third and a half were killed outright and another 50,000 or so were fatally injured. Citizens of Hiroshima are still dying at the rate of about 100 per year from causes directly attributable to the atomic bomb. In 1960 the American Atomic Bomb Casualty Hospital there treated over 18,000 persons for radiation disease and other bomb injuries. A conservative estimate would place the deaths in the New London and West Groton areas near 90 per cent. Outside the three or four mile radius the death rate would drop drastically but the numbers of serious injuries from all causes would be very great. Out as far as Niantic, Norwich and Mystic, people who were knowledgeable, well prepared, reasonably lucky and ruthlessly selfish in taking care of themselves would probably be uninjured.

If that single atomic bomb were the only act of war which affected this area or surrounding areas, the answer to the question of survival and regeneration of the community as a whole could be answered quite optimistically. After a few months of extreme exigency in which privation, suffering and regimentation would be the common lot of the survivors, Groton and New London would be rebuilt. The people of Southeastern Connecticut, aided by other more remote communities, would within a year be well on the way toward recreating a community in this area.

Reasoning from the analogy of Hiroshima, one would expect that a modern new city would be built on the rubble of the old. In five years time little physical evidence of the bombing would remain. In Hiroshima only one twisted skeleton of a reinforced concrete building remains, deliberately left as a grim memorial of the incident of 8:15 a.m., Monday, August 6, 1945; otherwise the city has been entirely rebuilt and is now as populous and prosperous as before the bombing.

But there would be ample human evidence of the bombing, remaining for the lifetime of the survivors and perhaps for generations to come. These would be the crippled and deformed, the scarred and blinded, the malformed mutated children of the survivors who suffered genetically damaging but less than killing dosages of radiation.

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The possibility of recreating a community life in this area after a general nuclear attack is, to put it as mildly as possible, much less promising. But it will be more meaningful to consider such possibilities after examining the effects of modern nuclear weapons on this area.

The effects of a nominal 20 megaton nuclear weapon (24 million tons of TNT explosive equivalent) have been determined by several actual tests of such weapons. A bomb of this size is over a thousand times as powerful as the Hiroshima type weapon and causes correspondingly greater damage. If such a weapon were to explode at ground level near the Groton-New London bridge, it would leave a crater about a mile across and 300 feet deep. This huge hole and the sizeable circular hill of earth and radioactive debris which would surround it would cover what was once the downtown New London and Groton areas. The sites of the present State pier, the railroad yards, Winthrop school, and the State Police barracks would be from 100 to 200 feet down the slope into the crater. The Coast Guard Academy, downtown New London and Groton, and the Electric Boat factory would be buried under the lip of the crater formed by the fall-back of the nuclear excavation. The area of *total destruction,* even of the most heavily reinforced concrete structures, would extend out about four miles. This circle includes Ocean Beach, Jordan Village, all of Quaker Hill and Connecticut College, all of the Submarine Base, all of the housing near the Sub Base, Poquonock Bridge, and Trumbull airport. In this area there would literally not be a stone in place. Streets, building sites and other landmarks would be obliterated in a tangled mass of wreckage; even deep blast shelters would be destroyed. No human being in this area would survive even the instantaneous blast.

Out to an area of six miles radius, which includes Niantic, Flanders, Montville, Uncasville, Gales Ferry, much of Ledyard, Mystic, and Noank, all brick buildings, even those with few windows and heavy construction, would be totally destroyed and with them any basement shelters under them. Also in this area the blast would cause severe lung damage leading to virtual total casualties from this cause alone. At a radius of ten miles there would be total destruction of all frame buildings, damage beyond repair to all brick buildings, and serious (though partially repairable) damage to reinforced concrete structures. On the fringes of this area (beyond about 8 miles), which includes all of the towns of East Lyme, Waterford, Montville, Ledyard, New London, Groton, and the outskirts of Norwich, half of the town of Stonington (including the Village) and all of Fishers Island, deep blast shelters would be effective protection but basement fallout shelters would be of no use.

At a radius of 15 miles (a circle beginning at the town of Saybrook, touching Essex and Hamburg, including all of the town of Salem, all of Bozrah, going well beyond Norwichtown and Taftville, including all of the towns of Preston and North Stonington, the city of Westerly, Rhode Island, and the whole Watch Hill area) all frame buildings would be damaged beyond repair and any basement shelters under them would be badly compromised. Brick buildings would be severely damaged but generally repairable. In this area much damage would be done by flying objects, not the least of which would be people. AEC tests which have included dummies resembling human bodies left in the open have shown that a very serious cause of casualties will be flying human bodies, thrown through the air by the initial blast effect. Minor damage to houses and other construction, such as broken windows, falling plaster, and cracked walls, will extend out from the center over 100 miles.

The area of instantaneous killing radiation, intense enough to penetrate more than two feet of concrete or earth, will extend out from the center to a radius of two and a half miles, including all of New London, the Cohanzie and Quaker Hill sections of Waterford, Connecticut College, all of the Submarine Base, and all of the town of Groton as far away as Poquonock Bridge. But in this area total killing by radiation is simply added to total killing by blast.

Again, the truly awesome destructive effects of radiation are shown by the fallout from the bomb. The energy released by large nuclear weapons is divided among three major effects; somewhat over a third appears as blast, a third as heat, and less than a third appears as radioactivity. Nearly half of this radioactivity will be carried by the huge mushroom cloud into the stratosphere and will be more or less equally

distributed over the whole earth. Much of the radioactivity of this world-wide fallout will be lost while it is remotely high up; the remainder will be so evenly distributed over the surface of the earth that it is of no concern in the local crisis. The most damaging effect is caused by the so called "local" fallout, that which falls within several hours of the detonation and within a couple of hundred miles of the center of the burst. This local fallout is distributed in two patterns. The major one is a long elliptical area up to 250 miles long and about 40 to 50 miles wide, with the long dimension in the direction of the prevailing winds. From our hypothetical bomb dropped on the Thames river bridge a deadly wave of fallout would sweep to the northeast. Providence — and the whole state of Rhode Island — would be covered within two hours; Boston and all of Massachusetts between there and and Cape Cod would be covered within four hours after the detonation here. Over half of this huge elliptical pattern of "local" fallout would fall harmlessly into Massachusetts Bay and the Gulf of Maine — harmless that is, except that the fish and other sea life in this area would become too radioactive to eat for several months after the incident.

The second pattern of local fallout from this bomb would be of much more concern to us in Southeastern Connecticut. This pattern is roughly circular, about 25 miles in radius; it would start at Madison on the coast, include most of Middlesex County, just miss Middletown, include Willimantic to the north and the southwestern third of Rhode Island to the east; it would just miss Block Island and include the tip of Long Island as far back as Sag Harbor. Within this area large particles of fallout would rain down almost immediately after the bomb detonation; within an hour the whole area would be covered by a deep layer of wildly radioactive dust. It is not possible accurately to predict the level of this radioactivity within the area close to the bomb site. The most pertinent estimate is one made by the Naval Radiological Defense Laboratory. This institution has made the most detailed studies of actual fallout levels in the Pacific bomb tests and on the basis of these actual measurements has estimated the *average* level of fallout radioactivity over the whole land surface of the United States which would result from the explosion of 263 hydrogen weapons on strategic and population targets scattered throughout the country. On the basis of their estimates the *average* level of fallout radioactivity would be 7500 roentgens per hour at the end of the first hour. Since there are sizeable areas which would have no fallout at all, clearly some areas would have levels of radioactivity inordinately higher than the average and certainly among these would be the area immediately surrounding a big bomb drop. An extremely conservative estimate would be that the 25 mile circle around New London would have

an initial (end of the first hour) level of radioactivity of 20,000 roentgens per hour (roughly three times the average); the level in the elliptical pattern would be much lower than this, probably less than twice the Naval Laboratory Radiological Laboratory estimate of average radioactivity.

A dose of radiation between 300 and 500 roentgens has a 50% probability of being fatal; a dose of around 700 to 900 roentgens is always fatal. Thus anyone exposed to the fallout within the 25 mile circle for as long as two minutes during the first hour would certainly die of radiation damage; in Providence the fatal exposure would be 10 to 20 minutes during the second hour.

Further consideration of the damaging effects of the fallout radiation and the possibility of protection against it must take cognizance of three factors. The first is that the level of radioactivity decreases rapidly with time because of the natural decay of the radioactive materials. A complicated mathematical formula governs the rate of this disintegration but the decay in intensity can be described in understandable terms by stating that the decrease is about ten-fold for each seven-fold increase in time. Thus, at the end of seven hours the level of radioactivity in Southeastern Connecticut would be about 2000 roentgens per hour. (This describes the levels on the fringes of the 25 mile circle; they would be much greater near the center of the circle and lower at greater distances.) At the end of two days the level at the fringes would be about 200 roentgens per hour; at the end of two weeks it would be 20; in four months it would be 2 roentgens per hour.

The second factor to consider is the protection offered by various structures or shelters. An automobile or the first floor of an ordinary home offers a protection factor of about 2. That is, a person in (or under) an automobile or inside a house would receive only half the radiation he would in the open. In the basement of a house the factor would be between 10 and 100; the best basement shelter recommended by OCDM has a protection factor of about 1000; a self contained deep blast shelter would decrease the radioactivity by several thousand.

The third factor to consider is that harmful effects of radiation are cumulative. That is, if a person in Willimantic, say, heard the explosion in New London and came out in the open to see what it was and stayed out long enough to be exposed to radioactive fallout for 30 seconds, he would have received about 150 roentgens. If he then went inside and took another 30 seconds to pick up his portable radio, he would have received another 75 roentgens. If he then went immediately to a near per-

fect deep blast shelter and stayed there from then on, he would still be in danger of dying from radiological exposure. He would have received 225 roentgens in the first minute; in the next hour he would receive about 5 roentgens, assuming a protection factor of 4000 for his shelter. If he remained inside his shelter *constantly* for the next six months he would receive just under 20 roentgens more radiation. This would be broken down as follows (assuming that his shelter attenuated the radiation to 1/4000th of its unshielded level): during the period from 2 to 24 hours after the bomb drop, 11 roentgens; the next six days, 3.5; the second week, 0.7; third week, 0.4; fourth week, 0.3; second month, 0.5; next four months, 0.7; for a total of 22 roentgens while in the shelter. This person's total radiation exposure is thus about 250 roentgens, somewhat less than the average lethal dose. In a good basement shelter with a protection factor of 250 he would have received a total of about 600 roentgens.

It should be said in mitigation that the damaging effects of radiation are not exactly additive. There is good evidence of partial recovery between doses of radiation which are spread out over time. Thus a dose of 600 roentgens would be fatal to about 75% of the subjects if received in one brief exposure; in this situation where about half the dose is spread over six months the probability of death from radiation injury is considerably less.

The chances of survival for people further out from the bomb blast would be much better; but those closer in would have much less chance. Also it is quite clear that the first minute, the first hour, the first day are the times when protection is most effective. If a person is *inside* an adequate shelter at the time of detonation and has an adequate supply of uncontaminated air, food, and water and sanitation facilities to hold out in a *deep* shelter for the first few weeks, he can then safely stand brief periods of exposure to the unshielded radiation from fallout.

After describing the effects of radiation it is almost too much to turn now to the effects of the fire which would be an inevitable result of this hypothetical nuclear incident in Southeastern Connecticut. But the searing heat and the attendant fire storm are facts of nuclear war and any serious appraisal of this incident must consider them. The detonation of the bomb takes place in less than a millionth of a second. During that time the materials of the bomb itself and all substances near it, the earth, water, steel, concrete, are vaporized, then are heated to temperatures in excess of a hundred million degrees and are compressed to many billions of pounds pressure. A huge fire ball develops, increasing in size quickly to two miles across and rising at a rate of 300 miles per hour to a height of 25 or 30 miles. There are two pulses of heat radiation, the first lasting

only a fraction of a second, the second reaching a maximum in a few seconds but lasting for half a minute or more. If our hypothetical man in Willimantic had looked at this fire ball, he would have had a very brief impression of something many hundreds of times brighter than the noon sun — then he would have been blinded permanently; his exposed flesh would have been charred; his clothing would have been burned off him. His frame house would burst into flame; his lawn, shrubs and trees would take fire; his asphalt driveway would melt.

The range of third degree burns to exposed people would be 25 to 30 miles out from this bomb. This would also mark the edge of the fire storm, in principle like the one described for the small, old fashioned atomic bomb but vastly greater and more devastating. The wooded areas of Southeastern Connecticut and Southern Rhode Island, extending from the Connecticut River almost to Narragansett Bay and north almost to Glastonbury and Danielson, would form one huge fire raging through the whole area, swept toward the center by 200 mile an hour winds. This fire would be many orders of magnitude greater than any ordinary forest fire. It is almost certain that it would only be extinguished by ultimately consuming all combustible material in its path. There would be some light rainfall along with the fallout during the early stages of the fire storm. But this would be ineffectual in controlling the fire and would also bring more unpleasant and dangerous material down with it. An example of such noxious secondary products of the bomb which would fall over the devastated area is the 120,000 tons of nitric acid which the nuclear explosion forms from the nitrogen and oxygen of the air.

It is possible that many people in the outlying areas might survive this combination of assaults on human life. But any attempt at prediction of numbers would be meaningless. Geographic location, precautionary measures, and intelligent understanding of the nature and the timing of the threats would be important factors in determining individual survival. But the most important factor of all would be plain luck. If a particular unique set of circumstances prevailed so that the blast, the initial flash of heat, direct radiation, flying objects, falling buildings, fallout radiation, and ingested radioactivity were *all* avoided, then the lucky person might survive to deal with the untold, almost unimaginable, exigencies of the post-attack period. But if any single one of the primary threats could not be avoided then post-attack living would be no problem.

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The third hypothetical situation which should be examined is that in which no bombs are detonated in Southeastern Connecticut but some

reasonably probable level of nuclear attack is suffered by the New York - New England area. In the 1959 Joint Congressional Committee estimates seventy metropolitan areas in the United States were assumed to have been hit by a total of 550 megatons explosive equivalent. This is a truly mild attack in view of the known Russian capabilities which include at least 40,000 megatons of nuclear weapons and adequate means (aircraft and missiles) to deliver most of them. Furthermore, the sizes of weapons tended on the small side of what might be reasonably expected. Ten megaton weapons were the largest considered in this hypothetical study and most were in the one to three megaton size — in spite of the fact that the standard big nuclear weapons, easily carried even by medium bombers, are the 20 megaton size.

In the Congressional estimates it was assumed that New York and Boston would each be hit by two 10 megaton bombs; Providence by one 10 megaton; Albany by an 8 megaton; Hartford and Springfield by a 3 and 2 megaton each; Bridgeport, New Haven and Worcester by one 3 megaton each; and New Britain and Waterbury by a one megaton each. Thus, within a 100 mile radius of Southeastern Connecticut about 80 megatons of nuclear explosive would be detonated in a minimal attack. The distances of even the closest bursts are such that our community might escape the major blast and fire damage. The remaining major effect, radiation, would come from the local fallout. If there were a strong and persistent wind from the straight south, we would escape the worst of the fallout; if the wind were from any other direction, we would be in an area of fallout more intense than any except in the immediate vicinity of nuclear explosions. The prevailing south westerly wind would put us in the direct path of the fallout from the highest concentration of bombs in the nation. Consideration of the Naval Radiological Defense Laboratory estimates of an average level of radiation of 7500 roentgens per hour makes it reasonable to assume a level of twice this, 15,000 roentgens per hour, near this heavily bombed area.* This would be the level of fallout radiation at the end of the first hour after detonation, about the time heavy fallout would reach this area. Under these conditions unprotected exposure for five minutes would be a certainly lethal dose of radiation.

To examine the effects of this radiation it is simplest to make a timetable of how much radiation a person in the open would be likely to receive and then consider various types of protective measures he might take. If one takes the above assumptions: (a) that serious fallout reaches this area the first hour after detonation and (b) a level of 15,000 roentgens

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* This value, based on N.R.D.L. estimates, was corroborated quite closely by computations on two other independent sets of data.

have dropped to about 1 roentgen per hour; in four years it would be about 0.1 roentgen per hour.

The head of a household would probably be willing to risk exposure to radiation by leaving the shelter as much as an hour a week after the first two weeks of extremely intense fallout radiation. On such a schedule he would receive a total of about 150 roentgens in six months time. This would include the 75 roentgens he would receive during the major part of his time which he spends inside the shelter; the other 75 roentgens would have been his hour a week dose of direct radiation in the open. Half of this dose would have been the expense of his first four excursions out of the shelter, while an hour spent in the open six months after bomb day would cost him only about 1 roentgen. A person could avoid death by radiation on such a schedule but it is questionable whether he could avoid death by starvation or disease. And it is perfectly clear that no semblance of community life or function could be recreated. If the survivor could manage to avoid *any* exposure during the first month, then he could double his time above ground during subsequent months and still get the same exposure of 150 roentgens. But two hours a week could hardly be considered active community participation.

To complete the dismal prospect it is necessary to point out the difficulty of recreating a normal existence even after six months of imprisonment in a shelter. During the second half of the first year the average level of fallout radioactivity would be about 0.7 roentgens per hour, a level that makes human occupancy impossible. A person exposed to this radiation for six months would receive 3000 roentgens, probably a fatal dose even spread over so long a time. During the fifth year after the disaster, when levels of radioactivity would be slowly decaying from 0.1 roentgen per hour, a person who is constantly exposed would get a dose of something over 800 roentgens per year — a fatal injury in a single short dose but perhaps only a third of the fatal dose when taken slowly.

The possibility of recreating this highly organized, industrial and partially urbanized community could only remain a dream of the future. Even the chance of a general rural farming community is slim. Undoubtedly natural changes in surface features of the land, greatly hastened by the excessive erosion of a denuded landscape, would cause great redistribution of the radioactive material. There would be some areas which would be naturally decontaminated by this process; there would also be other areas where the concentration of radioactivity would build up. It is quite probable that spotty areas could be reclaimed for farming, but it would be necessary to constantly and carefully check the produce of these farms for dangerous concentrations of radioactivity. It is well known that many

plants and animals have a great tendency to concentrate some radioactive materials such as strontium 90 to levels far above their concentration in the soil. A safe and relatively unirradiated life in this area, even five years after the bombing, would depend first on a good working knowledge of the nature of radioactivity, its biological effects, its fallout origins, and its physical properties; it would also require considerable elegant radiological measuring equipment; it would also require a remarkable level of awareness, vigilance and restraint.

The likelihood of help coming from outside this area is almost nonexistent. All ordinary means of communication and transportation would be totally destroyed. After several weeks or a few months it might be possible for an airplane or a boat to come here briefly (if facilities to receive them could be improvised). But one is always faced with the question, "Where would help come from? What could be brought here that is not needed just as badly elsewhere?" The probability is very great that conditions would be just as terrible throughout the whole eastern seaboard area, at least as far away as Washington, D.C. The more remote areas of the South and West, though probably not hit as badly as New England, would have fantastically difficult problems of their own. They would surely have more survivors — but would also have many more sick, injured and starving to care for.

More probable than the arrival of teams of saviors would be the arrival of roving bands of marauders — frightened, injured, maddened, short-term survivors of other similarly devastated areas. If a person should be so lucky and so foresighted to have prepared and occupied in advance a perfect shelter stocked with the necessities of life underground, he might have to defend it against the raids of others who were not so lucky or so thoughtful in advance. He might even find it not worth defending.

Could we survive a nuclear attack?

Can shelters save us?

Is there *any* defense?

Is there anything we can do now to prevent this tragedy?

The one clear and effective thing we can do is to strive to ensure that these hypothetical incidents do not become actual ones.

Civil Defense Protest Committee
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